COMMONWEALTH MYCOLOGICAL INSTITUTE
9 JUN 1949

TANGANYIKA TERRITORY—DEPARTMENT OF AGRICULTURE AND SISAL BOARD

Sisal Experimental Station Annual Report for the year 1947

PART I.—Staff

1. *European.*—Mr. G. W. Lock, O.B.E., Senior Agricultural Officer, was in charge of the Station throughout 1947, assisted by Mr. E. Pienaar, Agricultural Assistant. Mr. Lock visited Mauritius from 2nd October until 10th November in order to report upon the local fibre industry. Mr. Pienaar returned from annual leave on 20th January and left for vacation leave on 25th December. Dr. P. I. Wilson, Research Chemist, who had been working for the past eighteen months at the station on sisal fibre research, returned to England on 21st March to continue his studies under Professor Speakman at Leeds University.

2. *African.*—The African staff numbers forty and no major changes have occurred since last year. In addition seven recorders are employed on external trials and six laboratory assistants on fibre testing. The average daily attendance of field workers and artisans is about 120 men, many of whom are regular employees already familiar with the technique of field experiments; they have also been employed on cutting the external field trials. The supply of general labour has been inadequate for routine and development work.

3. *Touring.*—The Senior Agricultural Officer visited the Central Line four times and Dar es Salaam twice during the year in connection with the external trials, visits to estates and attending meetings of the Sisal Board. Over a month was spent in Kenya at the beginning of 1947 working in collaboration with the High Level Sisal Research Station on a programme of external field experiments. The East African Agricultural and Forestry Research Conference held at Nairobi was attended in July. After inspection nine applications for additional land for sisal growing were reported upon to the Sisal Board. Many local estates were also visited. The Agricultural Assistant made one journey to the Central Line apart from several visits to external trials in the Tanga District.

Weather

4. During 1947 the total rainfall amounted to 42·04 inches which is about five inches below the average for Mlingano. The rainfall distribution was more satisfactory than in the previous year since 142 rainy days were recorded. The main rains approximated the norm but the small rains were rather delayed, most rain falling in November and December. Weather during the cool season tended to be overcast and dry.

General

5. Planting Work.—In March one new 9 × 9 quasi-Latin square was planted to test several degrees of severity and frequency of cutting on three levels of plant population. Owing to extensive sisal weevil damage the trial was uprooted and replanted in August under less favourable weather conditions and the sisal made a slow start. Another new trial to investigate the effects of cutting upon fibre characteristics was also replanted at the same time. The Nitrogen and Phosphate trials were replanted in May for the third cycle but the spacing was altered from the single-row to the double-row system. Special precautions were taken to protect the young plants from weevil damage and to reduce the number of casualties. Early growth was disappointing but the growth of this sisal improved later in the year. Three treatments in the Cultivation trial were replanted, two of which proved failures and further attempts will be needed in 1947. One trial for testing insecticides was planted and later proved unsatisfactory and was uprooted. Two $3 \times 2 \times 2$ bulbil nursery manurial trials were put down on exhausted land. Two acres of virgin land were cleared and planted with bulbils for next year's programme and this nursery has made excellent progress. Two acres were used for agave seedlings which were ready for transplanting into the field.

6. Five acres of land, originally cleared for agave hybrids in 1936, were fallowed under elephant grass (*Pennisetum purpureum*). About twenty acres were sown with velvet beans (*Mucuna* sp.). Seventeen acres of maize were grown and a fair crop obtained. Half of the area of 1946 cassava was lifted and sold to employees.

7. *Experimental Areas.*—Six of the earlier planted trials were continued and cut according to programme. The one hectare block of Blue sisal (*Agave amaniensis*) was cut out and uprooted due to the plants ceasing to make further growth upon approaching the poling stage. A small plot was planted with suckers in order to preserve this species of agave. A demonstration plot of sisal planted in double-rows was cut for the second time. Three acres of land fallowed for five years under elephant grass were ploughed preparatory to planting sisal next year.

8. *Agave Hybrids.*—Selection of the agave hybrids comprising mainly back-crosses of *A. amaniensis* and *A. angustifolia* was continued during 1947, all unsuitable plants being destroyed and now there are about five hundred left. Some of these plants poled and further pollination work was carried out. The unsuitable types proved either susceptible to disease or possessed massive leaf bases which provided prolific breeding grounds for the sisal weevil and their removal became essential in the interests of other experiments.

9. *External trials.*—There are three external spacing × cutting trials respectively sited at Rudewa and Kingolwira on the Central Line, and at Amboni in the coastal belt in the Tanga District. The Rudewa trial was the most forward and a first cutting was taken from certain of the plots in March 1947 according to the schedule of cutting treatments, but the Kingolwira trial was not ready at the same time and the initial cut had to be postponed until June, or twenty-seven months after planting. The Amboni trial, replanted in 1946 will not be ready for cutting until 1948; owing to weevil attack the sisal is not very uniform. A new $3 \times 2 \times 2$ Silico-phosphate manurial trial was planted on one estate in the Tanga District on a site where banding disease is severe.

10. *Pests.*—1947 will be memorable for an exceptionally bad outbreak of the sisal weevil (*Scyphophorus acupunctatus*) which was responsible for the uprooting of two new trials and considerable losses in others thus detracting from their uniformity. Drastic measures were called for since the weevil threatened to make it impossible to carry out field trials satisfactorily at Mlingano. Mention has already been made of the removal of a senescent plot of Blue sisal and many thousands of hybrids and it is hoped that in due course the weevil population on the Station will be greatly reduced. Poling sisal plants were destroyed as early as possible and all young sisal was protected by dusting with insecticides though the weevil continued to breed below ground level in the boles of small plants. The weevil problem has been the subject of further investigational work on a limited scale in collaboration with the Entomologist, Morogoro.

11. *Diseases.*—Deficiency diseases in the form of a leaf tip wither became more evident in localized patches in some of the older trials. This is a sign that the soil is approaching exhaustion levels due to continuous cropping with sisal. There were a few cases of bole rot, the majority occurring in the cutting trials.

12. *Citrus.*—With better seasons and facilities for watering, a considerable expansion of the citrus nurseries was made in anticipation of future demands. Over 15,000 stocks were transplanted and the majority were budded in 1947. Through intensive methods it is hoped that a large number will be ready for sale next year. A total of 2,186 citrus trees were supplied to sisal estates and others during 1947. Sales of citrus fruit continued.

13. *Stock.*—The cattle, which are housed in fly-proofed byres, maintained good health and there were fewer cases of *trypanosomiasis*. Seven calves were born and three of the young stock died. The total head of stock numbers twenty-eight.

14. *Buildings and Machinery.*—During the year a house and a laboratory were erected by the Public Works Department for the Soil Chemist (not yet appointed). Two quarters for the Senior African Staff were built in the labour camp, and reconstruction of kitchens was commenced. No extra machinery has been acquired but a new four-ton lorry and a pick-up motor vehicle were purchased.

15. *Water Supply.*—The dam filled to overflowing in May which assured a water-supply until next year. The pumping plant continues to work satisfactorily.

16. *Acknowledgments.*—Messrs. Kumburu Plantations, Ltd., have continued to afford the Station every assistance in decorticating experimental leaf at their Ngomeni factory which is gratefully acknowledged. Messrs. Bird & Co. (Africa), Ltd., also kindly helped the Station with facilities available on Geiglitz Estate. Thanks are also due to Messrs. Rudewa Estates, Ltd., and Messrs. Central Line Sisal Estates, Ltd., Kingolwira, for their co-operation in decorticating external trials.

17. *Planter's Day.*—Over one hundred members and guests of the Tanganyika Sisal Growers' Association attended a successful Planter's Day held at Mlingano on the 7th July, 1947. Visitors were shown round the experiments and a comprehensive display of diagrams and exhibits illustrating the results of past experimental work was prepared.

18. *Visitors.*—There was a considerable increase in the number of visitors to the Station especially from overseas. Prominent visitors include R. W. R. Miller, Esq., C.M.G., E. F. Hitchcock, Esq., C.B.E., Dr. B. A. Keen, Dr. E. B. Worthington, Dr. H. H. Storey, F.R.S., Major C. S. Duffus, Major E. R. Orme, N. C. S. Bosanquet, Esq., T. E. Baring, Esq. Dr. Alvaro Soeiro, V. R. Duarte, Esq., W. F. Lutyens, Esq., C. W. Aschan, Esq., Lord Hartington, and the Provincial Commissioner, Tanga.

PART II.—REVIEW OF EXPERIMENTS

The establishment of new experiments on the Station during 1947 was severely handicapped by an infestation of the sisal weevil. Owing to extensive weevil damage to young sisal it proved necessary to discard nearly fifty per cent of the plants raised in nurseries besides uprooting three trials which were planted during the main rains. These were replanted in August under less favourable conditions and special planting methods were adopted in an endeavour to combat the weevil menace. Hand collection of weevils, supplemented by regular applications of insecticides, was undertaken in order to protect the young plants. The introduction of these measures reduced losses caused by the weevil but the trials continued to suffer a number of casualties which has impaired their uniformity and efficiency. Rigorous elimination of weevil breeding grounds has also been practised.

Much of this report is devoted to studying the results of various ways of managing the sisal plant with particular reference to spacing and cutting. Although these aspects have been given considerable prominence it should not be overlooked that the Station is today primarily confronted with questions concerning the maintenance of soil fertility and plant nutrition as may be seen from the results obtained during the second cycle of certain trials. This involves problems of a magnitude and complexity which can only be solved in collaboration with other agricultural research workers in East Africa.

Cultivation Trial

Layout : 6 × 6 Latin Square.

Plot size : Twenty-five recorded plants spaced 3m. × 1m.

Commencement : April, 1936.

Treatments :

A. Uncontrolled weed and bush growth.
B. Weeding twice annually.
C. Surface clean weeding.
D. Cover crop (*Calapogonium mucunoides*).
E. Clean weeding and deep cultivation.
F. Weeds cutlassed twice annually.

All the original sisal in this trial has poled, the duration of its life-cycle varying from 59 to 107 months from planting according to the degree of weed competition. The clean-weeded plots were the earliest to pole and they were replanted in September, 1941 and now the second cycle is practically at an end since more than ninety per cent of the plants have poled. The other treatments were replanted during subsequent years, the last being the uncontrolled weed growth which was replanted in 1947. The second cycle sisal is therefore in various stages of development.

Present fibre yields and other data showing the progress of this trial are given in Table I.

TABLE I.—CULTIVATION TRIAL

Treatments	Clean Weeding Shallow C	Clean Weeding Deep E	Weeding Twice Annually B	Cover Crop D	Weed Cutlassed F	Uncontrolled Weeds A	Significant Diff.
FIBRE YIELDS (tons per hectare) :							
1st Cycle	14·44	14·46	12·10	11·81	11·67	11·34	1·04
2nd Cycle	11·40	11·08	5·21	7·44	—	—	—
Total to date	25·84	25·54	17·31	19·25	11·67	11·34	2·04
Mean No. of leaves produced per plant :							
1st Cycle	222	220	214	210	225	234	7·6
2nd Cycle	202	201	180	194	66	12	—
Mean No. of leaves cut per plant :							
1st Cycle	186	190	156	151	148	153	7·1
2nd Cycle	158	158	88	122	—	—	—
Mean weight of a single leaf (gms.) :							
1st Cycle	615	628	647	668	648	576	—
2nd Cycle	595	584	497	524	—	—	—
No. of months from planting to poling :							
1st Cycle	59	58	65	59	89	107	—
2nd Cycle	72	72	—	—	—	—	—

From the viewpoint of total yield of fibre in a given time, the clean weeding treatments are obviously ahead of the others due to their shorter life-cycles. It would be dangerous, however, to infer from these figures that continuous clean weeding is best for sisal and attention is drawn to a marked decline in the fibre yields obtained during the second cycle. Clean weeding promotes the growth of sisal, especially when it is young, mainly through conserving moisture but there are concomitant risks of the soil deteriorating through prolonged exposure and a lack of organic matter, besides soil erosion. A comparison of the soils from treatments C and A shows a distinct change in texture and colour, the former having less organic matter and being lighter in colour. It may be said that the soil has been sacrificed for the sake of the sisal, the converse applying to the very weedy treatment.

TABLE II.—COMPARISON OF FIRST AND SECOND CYCLE DATA

Treatment C—Surface clean weeding

Cycle	Date 1st	Date 2nd	No. of months from planting 1st	No. of months from planting 2nd	Leaf Stage 1st	Leaf Stage 2nd	%Poling plant 1st	%Poling plant 2nd
1st Cut	8/38	5/44	28	32	123	114	—	—
2nd Cut	6/39	6/45	38	45	161	157	—	—
3rd Cut	7/40	6/46	50	57	204	188	16	12
4th Cut	3/41	4/47	50	67	218	200	50	67
5th Cut	9/41	8/47	65	71	222	201	99	91

Cycle	Fibre Yields (tons p.Ha.) 1st	2nd	Mean No. of leaves cut per plant 1st	2nd	Mean Wt. of a single leaf (gms.) 1st	2nd	Mean Wt. of Fibre per leaf (gms.) 1st	2nd
1st Cut	2·94	1·88	... 65	43	... 567	483	... 13·6	13·0
2nd Cut	2·67	3·26	... 34	40	... 793	685	... 23·5	24·5
3rd Cut	4·99	3·19	... 45	40	... 756	679	... 33·1	22·9
4th Cut	2·42*	2·50*	... 24	28	... 505	563	... 28·7	25·0
5th Cut	1·42	0·56	... 18	7	... 552	490	... 24·0	25·9
Totals ...	14·44	11·39	... 186	158	... 645	595	... 23·3	21·2

*Includes yield from poling plants cut earlier in the year.

Table II gives a detailed comparison of the results of the first and second cycles for the surface clean weeding treatment (C). The second cycle sisal grew more slowly in the initial stages and it had a longer life-cycle. Cutting began at 32 months after planting but occurred at an earlier point in the leaf stage, i.e. after the plants had grown an average of 114 leaves per plant. A significant feature is that the mean total number of leaves produced was only about 200 per plant compared with 222 leaves per plant during the first cycle despite an earlier onset of cutting. It is possible that this is attributable to a lower nitrate status of the soil consequent upon continuous clean weeding for eleven years.

The difference in fibre yields between the two cycles is of the order of three tons per hectare. Reasons for the lower yield of the second cycle may be found in a big decrease in the mean number of leaves cut per plant as well as the lighter nature of the leaf. Mean weights of fibre contained in a single leaf also tended to be lower. The reduction in the number of leaves cut per plant is due to heavier losses of the earliest leaves owing to slower growth when the sisal was young, and, of course, to the smaller total number of leaves grown. The yield of the third cutting, usually the best obtained during the life of sisal was particularly disappointing in the second cycle; this may be partially attributable to the drought of 1946.

Some of the sisal in the clean-weeded plots exhibited symptoms of leaf tip wither. These comprise a yellow, and later purplish, coloration along the margins of the leaf at the tip end, the leaf curls up lengthwise and finally withers from the tip downwards. This is indicative of a soil deficiency.

Spacing Trial (*A. sisalana*)

Layout : 6 × 6 randomized blocks of eight plots each.

Plot size : 120 square metres.

Commencement : May, 1936.

Treatment	Distance (metres)	Density (plants per hectare)
A	2×0·50	10,000
B	3×0·50	6,666
C	2·40×0·65	6,410
D	2×1	5,000
E	2·40×1	4,166
F	3×1	3,333
G	2×2	2,500
H	3×2	1,666

Table III.—Spacing Trial

Combined Fibre Yield for 1st and 2nd Cycles, December 1947.

Treatment	A	B	C	D	E	F	G	H	Sig. Diffce
Plant population	10,000	6,666	6,410	5,000	4,166	3,333	2,500	1,666	
1st Cycle ...	32·82	23·22	21·18	16·72	14·13	11·95	7·62	5·34	1·08
2nd Cycle ...	—	—	3·02	3·51	14·86	13·16	10·49	6·71	—
Total to date	32·82	23·22	24·20	20·23	28·99	25·11	18·11	12·05	2·02

Up to date results of this trial are given in Table III. Treatments G and H were replanted for the third time during the year under review. Treatment A will become due for replanting for the first time in 1948.

There is little fresh comment to make on the progress of this trial though it may be reported that existing sisal at the higher densities is not so good as its counterparts in the first cycle with particular reference to densities above 5,000 plants per hectare. Weevil damage has also been fairly extensive and the plants tend to lack uniformity. The trial has necessarily had to be kept fairly free of weeds due to the narrow distances between the rows in the majority of the treatments.

Table IV.—Spacing Trial (*A. sisalana*)

Comparative Fibre and Leaf Data for the 1st and 2nd Cycles of Treatments F and E

LEAF DATE	F 3,333		E 4,166	
	1st Cycle	2nd Cycle	1st Cycle	2nd Cycle
Mean No. of leaves produced per plant ...	218	198	220	197
Mean No. of leaves cut per plant :				
1st Cut	57	46	52	40
2nd Cut	35	35	31	31
3rd Cut	38	39	35	32
4th Cut	21	36	28	42
5th Cut	3	3	9	8
6th Cut	1	1	3	3
Total to date ...	155	160	158	156
Mean weight of a single leaf (gms.) :				
1st Cut	634	528	561	488
2nd Cut	846	728	760	657
3rd Cut	581	706	572	678
4th Cut	498	599	506	600
5th Cut	595	552	527	529
6th Cut	1	1	3	3
Mean for cycle ...	648	632	592	594
Percentage of Poling	100	87	100	84
Life cycle in months (Replanted May 1942.)	80	68	89	68

FIBRE DATA

Fibre yields (tons per hectare) :	F 3,333		E 4,166	
	1st Cycle	2nd Cycle	1st Cycle	2nd Cycle
1st Cut	3·45	2·23	3·57	2·19
2nd Cut	3·34	2·89	3·30	2·77
3rd Cut	3·39	4·00	3·60	3·50
4th Cut	1·47	3·60	2·52	5·11
5th Cut	0·28	0·33	0·86	0·90
6th Cut	0·02	0·11	0·28	0·39
Total ...	11·95	13·16	14·13	14·86
Mean weight of fibre per leaf (gms.) :				
1st Cut	18·1	14·0	16·5	13·0
2nd Cut	28·4	24·6	25·4	21·2
3rd Cut	26·6	30·4	24·8	26·7
4th Cut	21·6	30·2	21·2	29·5
5th Cut	25·4	38·4	22·5	26·9
6th Cut	24·3	27·4	24·4	27·4
Mean for cycle ...	23·2	24·5	21·4	22·7
Percentage fibre extraction :				
1st Cut	2·85	2·73	2·93	2·66
2nd Cut	3·39	3·37	3·33	3·23
3rd Cut	4·57	4·30	4·33	3·95
4th Cut	4·33	5·03	4·19	4·91
5th Cut	4·27	7·36	4·27	5·09
6th Cut	3·88	6·11	3·86	5·83
Mean for cycle ...	3·57	3·88	3·61	3·82

Table IV provides a detailed statement of the fibre and leaf data of the first and second cycles respectively for treatment F and E. The second cycle is nearly complete since over eighty per cent of the plants have poled.

The total fibre yields for the second cycle approximate those obtained during the first cycle despite a decline in the total number of leaves produced per plant. On the other hand the total number of leaves cut per plant is nearly similar for both cycles due to the first cutting being taken earlier which reduced losses of the youngest leaves. The first cycle sisal was handicapped by the fact that the initial cutting did not occur until three years from planting or too late in the leaf stage for these two plant densities. It has to be borne in mind that the first cycle yields might have been slightly higher than the figures recorded, nevertheless it would appear that the effect of these treatments upon the rate of soil deterioration is not yet very marked.

Spacing × Cutting Trial

Layout : 9 × 9 Quasi-Latin Square.

Plot size : Varies from 50—69 square metre according to the spacing treatment.

Spacing Treatments : Population

a_0—4,000 plants per hectare

a_1—5,000 ,, ,, ,,

a_2—6,000 ,, ,, ,,

Spacing between rows :

b_0—2·5m. between rows.
b_1—2·0m. between rows.
b_2—4m × 1m. between rows.

Combinations of the a and b treatments give the following spacings :

a_0b_0—2·5m. × 1m.
a_0b_1—2·0m. × 1·25m.
a_0b_2—4·0m. × 1m. × 1m.
a_1b_0—2·5m. × 0·80m.
a_1b_1—2·0m. × 1·0m.
a_1b_2—4·0m. × 1·0m. × 0·80m.
a_2b_0—2·5m. × 0·67m.
a_2b_1—2·0m. × 0·83m.
a_2b_2—4·0m. × 1·0m. × 0·67m.

Cutting Treatments : Commencement of Cutting :

c_0—Commence cutting at two years.
c_1—Commence cutting at two and a half years.
c_2—Commence cutting at three years.

Cutting Cycles :

d_0— 9 months cycle.
d_1—12 months cycle.
d_2—15 months cycle.

This complex experiment has now been in progress for close upon six years. Heavy poling took place during 1947 in plots with densities of 4,000 or 5,000 plants per hectare, especially in those cases where cutting did not commence until three years after planting. Most of the remaining sisal at the present time consists of the 6,000 plant population plots, and to a lesser extent, the 5,000 plant population treatments which had been cut early in their life-cycle. None of the poled plots has been replanted but in due course the entire experiment will be repeated after the first cycle has been completed.

Details of fibre and leaf data accrued up to date are given in the following tables though it is emphasized that few definite conclusions can be formed at this stage of the trial.

TABLE V.—SPACING × CUTTING TRIAL—SPACING EFFECTS

Summary of Fibre and Leaf Data Results to 31st December, 1947

Treatments grouped for population densities :—

	4000	5000	6000
FIBRE DATA			
Yield in tons per hectare	13·68	14·88	14·38
Percentage fibre extraction	3·78	3·68	3·65
Mean weight of fibre per leaf (gms.) ...	24·6	24·0	22·8
LEAF DATA			
Mean No. leaves cut per plant	142·8	130·8	111·6
Mean weight of a single leaf (gms.) ...	641	648	603
Mean No. leaves grown since planting...	203·6	200·6	192·0
Percentage of poling plants	89·8	75·9	44·8

Now that poling effects have become operative it is clear that the lowest plant population treatment will not excel the other treatments in respect of fibre yields. The poling percentages reflect the influence of plant density upon the longevity of the sisal, and this is also borne out to a lesser degree of the mean number of leaves grown since planting. Despite the rather lighter leaf,

which tends to contain less weight of fibre, yielded by the high density treatment (6,000 plants), the yield of fibre is commensurate with that obtained so far from the 5,000 plant density and exceeds that yielded by the lowest density. A sizeable quantity of leaf may still be reaped from the high density plots since there is a greater proportion of unpoled plants. The trend of the results conforms with that of the original spacing trial at Mlingano during its first cycle.

TABLE VI.—SPACING × CUTTING TRIAL—SPACING EFFECTS

Treatments grouped for spacing between rows

	2·5m	2·0m	4×1m
FIBRE DATA			
Yield in tons per hectare	14·71	15·07	13·16
Percentage fibre extraction	3·69	3·72	3·67
Mean weight of fibre per leaf (gms.) ...	23·9	23·4	24·0
LEAF DATA			
Mean No. leaves cut per plant	131·5	134·5	119·0
Mean weight of a single leaf (gms.) ...	636	623	634
Mean No. leaves grown since planting...	200·5	203·4	192·6
Percentage poling plants	70·6	75·6	64·3

As regards distances between the rows of sisal, double-row spacing continues to be a disadvantage compared with single-row spacing in the matter of rates of growth and yield. The disparity has tended to increase slightly since last year and it appears to be attributable to more intense plant-to-plant competition brought about by the juxtaposition of the twin rows. One obvious concomitant of the slower growth of the double-row sisal is retarded poling. The difference in fibre yields between the 2·5m. and 2·0m. distances is probably not significant. Differences in leaf size (which is an index of general development) are also very small in all three treatments. It would thus appear that while double-row planting checks growth it does not necessarily affect the size of the plants.

TABLE VII.—SPACING × CUTTING TRIAL—CUTTING EFFECTS

Treatments grouped for commencement of cutting

	c_0 2 years	c_1 $2\frac{1}{2}$ years	c_2 3 years
FIBRE DATA			
Yield in tons per hectare	16·65	13·86	12·25
Percentage fibre extraction	3·76	3·71	3·61
Mean weight of fibre per leaf (gms.) ...	24·1	23·7	23·5
LEAF DATA			
Mean No. leaves cut per plant	156·9	131·5	102·0
Mean weight of a single leaf (gms.) ...	576	633	700
Mean No. leaves grown since planting...	202·4	197·2	196·9
Percentage poling plants	70·8	66·8	72·8

From Table VII it will be seen that commencement of cutting effects are considerably more pronounced than spacing effects at this juncture. Growth rates, and poling rates, do not differ much although there is a wide disparity in the average number of leaves cut per plant, favouring early commencement of cutting. A comparison of starting to cut at two years and three years from planting shows a difference of 4·4 tons per hectare in favour of the former treatment. It is unlikely that the loss of crop through delayed onset of cutting, implying the loss of the earliest leaves due to natural withering, can be made good by surviving plants. One noteworthy feature is a reduction in

the size of leaf brought about by early cutting but this does not lead to a corresponding reduction in the actual weight of fibre per leaf, and the resultant is a slightly improved fibre percentage. It is stressed that these cutting results only apply to the soil and climatic conditions pertaining to Mlingano and district.

TABLE VIII.

Treatments grouped for cutting cycles

FIBRE DATA	d_0 9 months	d_1 12 months	d_2 15 months
Yield in tons per hectare	15·63	13·80	13·52
Percentage fibre extraction	3·76	3·71	3·61
Mean weight of fibre per leaf (gms.)...	24·1	23·7	23·5
LEAF DATA			
Mean No. leaves cut per plant	140·8	123·6	120·8
Mean weight of a single leaf (gms.) ...	640	633	638
Mean No. leaves grown since planting ...	200·5	199·0	197·0
Percentage poling plants	68·7	71·6	70·1

No. of cuts taken up to January, 1948

c_0d_0 ... 6	c_1d_0 5	c_2d_0 ... 4	d_0 ... 15
c_0d_1 ... 4	c_1d_1 ... 4	c_2d_1 ... 3	d_1 ... 11
c_0d_2 ... 4	c_1d_2 ... 3	c_2d_2 ... 3	d_2 ... 10
C_0 ... 14	C_1 ... 12	C_2 ... 10	... 36

In respect of frequency of cutting, or cutting cycles, the data in Table VIII is not yet comparable owing to the periods up to the time of the last cutting differing for each treatment. Generally speaking the cutting cycle should vary according to the rate of production of new leaves which in turn may be affected by climate and, less markedly, the severity of cutting practised.

Interactions.—The following two-way tables (Table XI and X) afford a study of the effect of one factor in the presence of another each at three different levels. For the present the most interesting comparisons are between plant populations and distances between rows (a × b), and plant populations and commencement of cutting.

TABLE IX.—SPACING × CUTTING TRIAL

Two-way Tables . a × b *Treatments:*
Plant Populations :
No. of plants per hectare :

FIBRE YIELDS (tons per Ha.) :

		a_0 4,000	a_1 5,000	a_2 6,000	b
Distance between rows :					
2·5m.	b_0 ...	13·66	15·47	14·99	14·71
2·0m.	b_1 ...	14·02	15·60	15·61	15·07
4×1m.	b_2 ...	13·36	13·57	12·54	13·16
Plant Population ...	a ...	13·68	14·88	14·38	

Fibre Percentage :

	a_0 4,000	a_1 5,000	a_2 6,000	b
b_0	3·81	3·65	3·67	3·69
b_1	3·83	3·74	3·67	3·72
b_2	3·77	3·66	3·65	3·67
a	3·78	3·68	3·65	

Mean weight of fibre per leaf (gms.) :

b_0	24·6	23·6	22·9	23·9
b_1	24·2	23·6	22·5	23·4
b_2	24·8	24·6	22·5	24·0
a	24·6	24·0	22·8	

Mean No. of leaves cut per plant :

b_0	144·1	135·1	115·5	131·5
b_1	146·3	137·0	120·7	134·5
b_2	138·1	120·2	98·7	119·0
a	142·8	130·8	111·6	

Mean weight of single leaf (gms.) :

b_0	649	651	608	636
b_1	629	638	601	623
b_2	645	653	600	634
a	641	648	603	

Mean No. leaves grown per plant at 7th February, 1948 :

b_0	204·0	203·0	194·5	200·5
b_1	206·8	205·5	197·9	203·4
b_2	200·1	193·4	184·2	192·6
a	203·6	200·6	192·0	

Percentage poling plants at 7th February, 1948 :

b_0	94·4	73·6	43·7	70·6
b_1	89·0	81·1	56·7	75·6
b_2	86·1	72·9	33·8	64·3
a	89·8	75·9	44·8	

Mean number of leaves cut per plant.—At each level of plant population, single-row has yielded more leaf per plant than double-row to date. The number of leaves cut per plant decreases as the plant density rises for all of the spacing treatments and is lowest for the 6,000 plant density spaced in double-rows. These trends depend largely upon growth rates. So far the fewer leaves obtained from 5,000 and 6,000 densities have been more than compensated for by the higher plant populations which has resulted in the fibre yields being better than that for 4,000 plants per hectare.

Mean weight of a single leaf.—Differences are small except for a reduction in the mean weight of the leaf cut from the plots having a density of 6,000 plants per hectare.

Mean number of leaves grown per plant.—These leaf counts no longer show so clearly the differentiation in growth rates because poling effects have tended to equalize the figures. The 6,000 density double-row sisal still lags behind the other treatments.

Percentage poling plants.—The low density plots are close upon poling out more particularly those planted in single-rows. The table points to plant population being of greater importance than spacing between the rows relative to duration of the life-cycle.

TABLE X.—SPACING × CUTTING TRIAL

Two-way Tables — a × c *Treatments:*
Plant Populations :
No. of Plants per hectare :

FIBRE YIELDS (tons per Ha.) :		a_0	a_1	a_2	c
Commencement of cutting :		4,000	5,000	6,000	
2 years	c_0	15·75	17·23	16·97	16·65
2½ years	c_1	13·37	14·90	13·88	13·86
3 years	c_2	11·93	12·51	12·30	12·25
Plant Population	a	13·68	14·88	14·38	
Fibre Percentage :					
	c_0	3·83	3·75	3·75	3·78
	c_1	3·87	3·68	3·66	3·67
	c_2	3·68	3·57	3·54	3·60
	a	3·78	3·68	3·65	
Mean weight of fibre per leaf (gms.) :					
	c_0	23·7	22·5	21·8	22·6
	c_1	24·8	24·0	22·4	23·6
	c_2	25·5	25·7	24·3	25·1
	a	24·6	24·0	22·8	
Mean No. of leaves cut per plant :					
	c_0	171·8	160·3	138·6	156·9
	c_1	140·0	128·7	110·2	131·0
	c_2	116·6	103·3	86·0	102·0
	a	142·2	130·8	116·6	
Mean weight of a single leaf (gms.) :					
	c_0	597	585	551	576
	c_1	645	654	601	633
	c_2	699	725	678	700
	a	641	648	603	

Mean No. leaves grown per plant at 7th February, 1948 :

	a_0	a_1	a_2	c
	4,000	5,000	6,000	
c_0	207·2	204·3	195·6	202·4
c_1	202·3	199·2	190·2	197·2
c_2	201·5	193·4	190·8	196·9
a	203·6	200·6	192·0	

No. of leaves cut per hectare :

c_0	687,200	801,500	831,600	773,400
c_1	560,000	643.500	661,200	621,600
c_2	466,400	516,500	516,000	499,600
a	571,200	654,000	669,600	

Percentage poling plants at 7th February, 1948 :

c_0	95·2	73·6	43·6	70·8
c_1	84·8	73·3	42·4	66·8
c_2	89·6	80·7	48·3	72·8
a	89·8	75·9	44·8	

Commentary on Table X

Fibre Yields.—Delayed onset of cutting leads to lower yields irrespective of the plant population. The yields of the 4,000 density plots are not likely to change very much from now onwards since a high percentage of the plants have poled. On the other hand more crop may be expected from the 6,000 density plots where poling is not so advanced, and therefore it might transpire that these treatments will ultimately give the best fibre yields.

Fibre Percentage.—Sisal cut at two years has a better overall fibre percentage than that cut at three years from planting. Plant population has not exerted any marked influence upon fibre percentage.

Mean weight of fibre per leaf.—Leaf from plots cut late tended to contain a rather greater amount of fibre than leaf from plots cut early. The figures also vary inversely with plant population which is mainly attributable to the disparity in growth rates.

Mean number of leaves cut per plant.—Early commencement of cutting means that a high proportion of the total number of leaves grown per plant is harvested. It will be noted that fifty-five fewer leaves were cut from a plant cut at three years compared with one cut at two years from planting. The data is not final hence the figures diminish according to rising plant population. Once again this is chiefly due to dissimilar growth rates.

Mean weight of a single leaf.—Deferment of cutting is conducive to heavier leaf but the increased weight is to a large extent accounted for by more leaf tissue rather than a greater quantity of fibre. Leaf size is little affected by plant population.

Mean number of leaves grown per plant.—Differences in growth rates between the treatments are not so noticeable as last year due to poling effects.

Number of leaves cut per hectare.—These calculations help to illustrate the combined effect of plant population and commencement of cutting upon the quantity of leaf reaped from one hectare. To date most leaf has been garnered from the high density sisal which was cut early.

Percentage poling plants.—The time when cutting was started is shown to have little influence upon poling though previous trials have indicated that early commencement of cutting may defer poling.

Severity of Cutting Trial—1947

Although it is not yet valid to draw any definite conclusions from the foregoing Spacing × Cutting trial, certain salient features emerge from the discussion of the results. As regards the main treatments it may be noted that plant population and commencement of cutting, either separately or together, make for greater differences in yield than either the espacement between the rows or the cutting cycles. All the plots have been cut leniently, leaving twenty-eight leaves per plant at each cutting, and the cutting treatments do not include various degrees of severity of cutting.

In order to take advantage of the above trends and to incorporate a wider range of cutting techniques, a new 9 × 9 quasi-Latin square severity of cutting trial was designed and planted on virgin land at Mlingano in 1947. This experiment embodies three plant populations, viz. 4,000, 5,000, 6,000 plants per hectare, all of which are planted in double-rows spaced 4 × 1 metres. The actual spacings correspond to the treatments a_0b_2, a_1b_2, and a_2b_2 in the 1942 trial and double-row was chosen because it allows of mechanical cultivation. Cutting will begin at two, two and a half and three years as before but the cycles have been changed to six, twelve and eighteen months which partly conform with estate practice in Tanganyika. There will be three levels of severity of cutting, light, normal and hard cutting.

It is hoped that this experiment will eventually provide results of greater interest to the sisal grower. Treatments will range from a low plant population which is cut late, infrequently and lightly to the other extreme of a high plant population which is both cut early, and cut hard at close intervals. These treatments are not due to be applied until 1949.

External Spacing × Cutting Trials

The Station is responsible for conducting three external spacing × cutting trials situated on Rudewa, Kingolwira and Amboni estates. These trials are modelled on the same lines as the original experiment at Mlingano but, of course, under different soil and climatic conditions. The Rudewa and Kingolwira trials were put down in 1945 and the cutting treatments have been carried out regularly every quarter by the Station staff since early 1947. The Amboni trial was uprooted and replanted in 1946 owing to serious weevil damage and becomes due for cutting in 1948.

Of the two experiments on the Central Line, the Rudewa trial is the most advanced and cutting commenced at two years from its inception according to plan. The Kingolwira trial was not quite so forward due to a lower rainfall and the initial cutting had to be deferred until the sisal was two and a quarter years old. Comparative current growth and fibre data for the nine spacing treatments are given in Table XI.

Table XI.—External Spacing × Cutting Trial

Distance Between rows	RUDEWA				KINGOLWIRA			
	Plant Population							
	a_0 4,000	a_1 5,000	a_2 6,000	b	a_0 4,000	a_1 5,000	a_2 6,000	b
Mean No. of leaves grown per plant at 15th March, 1948 :								
b_0	138·0	129·2	126·3	131·2	128·3	118·5	112·9	120·0
b_1	134·5	132·9	122·0	129·8	129·4	119·2	106·2	117·1
b_2	135·4	119·9	120·2	125·2	125·4	119·1	108·5	117·6
a	136·0	127·4	122·9		128·6	118·6	109·3	
Mean length of a last unfurled leaf in cms. at 15th March, 1948 :								
b_0	131·6	131·0	130·7	131·1	118·1	113·6	113·7	115·2
b_1	129·8	129·7	125·9	128·5	117·2	107·6	102·6	109·1
b_2	141·1	131·0	133·1	134·9	119·3	119·5	113·4	117·4
a	134·2	130·4	129·2		118·2	113·6	109·9	
Fibre Yields in tons per hectare at 15th March, 1948 :								
b_0	3·31	3·38	3·34	3·35	2·46	2·22	2·33	2·33
b_1	3·20	3·44	3·38	3·34	2·61	2·07	1·75	2·14
b_2	2·98	2·65	2·85	2·83	2·08	2·29	1·85	2·08
a	3·17	3·16	3·19		2·38	2·20	1·98	
Percentage Fibre Extraction :								
b_0	2·60	2·46	2·45	2·50	2·42	2·46	2·36	2·41
b_1	2·60	2·51	2·50	2·54	2·46	2·36	2·41	2·41
b_2	2·49	2·44	2·38	2·44	2·28	2·29	2·25	2·27
a	2·56	2·47	2·44		2·38	2·37	2·34	
Mean weight of fibre per leaf (gms.) :								
b_0	13·9	13·3	12·8	13·3	12·1	10·7	10·3	11·0
b_1	14·1	13·4	12·8	13·4	12·7	10·5	8·6	10·6
b_2	13·7	11·9	11·0	12·2	10·9	10·5	9·2	10·2
a	13·9	12·1	12·2		11·9	10·6	9·3	
Mean No. of leaves cut per plant :								
b_0	61·1	53·3	47·2	53·9	49·9	42·9	39·2	44·0
b_1	58·7	55·0	46·1	53·3	53·4	40·1	34·9	42·6
b_2	56·7	47·0	45·4	49·7	49·1	45·1	36·1	43·0
a	58·8	51·8	46·2		50·8	42·7	36·7	

Mean weight of a single leaf (gms.) :

	a_0 4,000	a_1 5,000	a_2 6,000	b	a_0 4,000	a_1 5,000	a_2 6,000	b
b_0	518	522	509	512	492	439	435	455
b_1	528	527	495	513	501	428	360	430
b_2	545	482	449	492	463	446	391	434
a	530	510	484		485	438	395	

No. of cuts taken at 15th March, 1948 :

Commencement of cutting

Cutting Cycle :	RUDEWA C_0	RUDEWA C_1	RUDEWA C_2		KINGOLWIRA C_0	KINGOLWIRA C_1	KINGOLWIRA C_2	
d_0	3	2	1	6	3	2	1	6
d_1	2	2	1	5	2	2	1	5
d_2	2	1	1	4	2	1	1	4
	7	5	3	15	7	5	3	15

These interim results serve to show the progress of each trial only. The yields of Rudewa experiment compare favourably with those of Kingolwira since the sisal has made better growth which has been fostered by a fertile soil. At the moment, early cutting at both places has tended to shorten the stature of the plants especially at the high densities. Starting to cut the sisal at three years was attended by fairly considerable losses of the lower leaves through withering especially at Rudewa. Here it would appear that cutting might suitably begin at two years for the 4,000 and 5,000 plant populations and two and a half years for a density of 6,000 plants per hectare. Early cutting is a great aid in the management of double-row sisal enabling suckers and arrears of weed growth to be removed before they get out of hand. Close cutting-cycles of six or nine months help to reduce the risks of leaf becoming damaged in the field.

Factorial Manurial Trial

Layout : 3 × 3 × 3 × 3 design with nine blocks of nine plots each confounding three factor interactions.

Plot size : Twenty-four recorded plants spaced 2·5m. × 1m. (4,000 plants per hectare).

Planted : April, 1942.

Treatments : Applications in cwts. per hectare.

NITROGEN (Sulphate of Ammonia)	PHOSPHATE (Rock Phosphate)	POTASH (Sulphate of Potash)
n_0 — nil	p_0 — nil	k_0 — nil
n_1 — 3 cwt.	p_1 — 4½ cwt.	k_1 — 3 cwt.
n_2 — 6 cwt.	p_2 — 9 cwt.	k_2 — 6 cwt.

Number of applications :

t_0 — once (1942) t_1 — twice (1942, 1943) t_2 — thrice (1942, 1943, 1944).

This trial is sited on land which had previously carried one cycle of sisal and the population of plants was increased from 3,333 to 4,000 per hectare. Poling has been fairly heavy but sporadic, mostly due to the irregularity of the plants caused by weevil damage during the young stages.

TABLE XII.—YIELD DATA UP TO NOVEMBER, 1947—4 CUTTINGS

	Fibre Yields in tons per Hectare	Leaf Data No. of leaves cut per plant
Nitrogen :		
n_0 — Nil	12·19	142
n_1 — 3 cwt. Sulphate of Ammonia per hectare	12·39	144
n_2 — 6 cwt. Sulphate of Ammonia per hectare	12·71	145
Phosphate :		
p_0 — Nil	12·54	146
p_1 — 4½ cwt. Rock Phosphate per hectare	12·44	143
p_2 — 9 cwt. Rock Phosphate per hectare	12·32	142
Potash :		
k_0 — Nil	12·76	146
k_1 — 3 cwt. Sulphate of Potash per hectare	12·34	144
k_2 — 6 cwt. Sulphate of Potash per hectare	12·19	141
Applications :		
t_0 — Once	12·32	144
t_1 — Twice	12·10	142
t_2 — Thrice	12·88	145

None of the differences in Table XII is significant and a glance at the figures is enough to show the manurial treatments have not increased yields. The results suggest that the dressings were neither heavy enough nor very long lasting. Previously a significant response was recorded in favour of nitrogen but this no longer pertains. It might be expected, of course, that the nitrogenous dressings would be rapidly taken up by the sisal or else leached out of the soil and therefore the benefits would be short-lived. As regards the phosphatic dressings, it is known that rock phosphate is a slow-acting fertilizer and furthermore there exists a possibility that any available phosphate has been rendered unavailable to the sisal by an acidic red soil. Earlier manurial trials at Mlingano also showed no response to potash.

The micro-plot technique of soil testing, introduced to East Africa by Mr. R. V. Holme of Messrs. Imperial Chemical Industries, Ltd., has been used twice in this particular trial area. This method employs maize as an indicator crop and the responses to various fertilizers may be measured within the space of one month. The micro-plots indicated that the soil was deficient in nitrogen and phosphate but there was no reaction to potash.

NITROGEN AND PHOSPHATE MANURIAL TRIALS

Both of these trials were replanted in 1947 on the double-row system. The spacing was changed from 3 × 1m. to 4·25 × 1m. in order to allow for mechanization and strip clean weeding. This is the third time of replanting and the soil has been carrying sisal continuously since 1936. One object is to ascertain if there are any residual effects from previous manurial dressings since no further applications will be made.

The young sisal made a slow start and its uniformity was somewhat marred by weevil damage though it is now well established and has a better colour. However on the whole the plants lack the vigour and breadth of leaf usually associated with young sisal on a fertile soil.

These trials demonstrate the feasibility of replanting rotational areas without burning when the double-row system is employed. All previous crop residues, weeds and trash were piled between the strips to be cultivated and planted with sisal. Within a year most of this material had rotted down and subsequent weed has been satisfactorily controlled by three to four disc-harrowings annually. Hand labour was used monthly for weeding the cultivated strips.

External Manurial Trial (Banding Disease)

Layout : 3 × 2 × 2 design in six sub-blocks.

Plot size : Twenty-four recorded plants spaced 4m. × 1m. × ·80m. (5,000 plants per hectare).

Planted : 2nd April, 1947.

Treatments :

p_0 — no phosphate.
p_1 — 5 cwt. Silicophosphate per hectare.
p_2 — 10 cwt. Silicophosphate per hectare.
n_0 — no nitrogen.
n_1 — 2½ cwt. Sulphate of Ammonia per hectare.
k_0 — no potash.
k_1 — 100 lb. Sulphate of Potash per hectare.

This trial is sited on land in the Tanga District where previously the sisal had suffered severely from banding disease. The soil is a blackish-grey clayey loam and outwardly appears to be fertile. The natural ground cover is mainly herbaceous weeds and grasses are conspicuously absent. Healthy, well-developed planting material taken from the Mlingano nurseries was used which struck satisfactorily. The artificial fertilizers were applied on 30th July, 1947.

Banding disease symptoms were not very marked by the end of the year but observations made subsequently indicated that they are greatly reduced by applications of potash.

Bulbil Manurial Trial

Two sites on sisal exhausted land were selected for putting down two 3 × 2 × 2 design bulbil manurial trials. In the early stages there was an improvement in colour in plots receiving nitrogen but it was only of a temporary nature. Subsequent growth has shown that soil differences were greater than treatment effects. In future trials the manurial dressings may have to be heavier and possibly applied more than once.

Fibre Characteristics Trial—1947

Layout : Four Randomized blocks of eight plots each having three sub-plots.

The object of this small experiment, planted in 1947, is to test whether cutting bears any relationship to the fineness of sisal fibre. Preliminary work carried out by Dr. Wilson at Mlingano suggested that once cutting began the fibre tended to become coarser.

The trial involves the study of individual plants which are not cut out according to time but according to their leaf stage, and thereafter at intervals of twenty leaves up to the 140 leaf stage in the remaining treatments except

that one plot will not be cut until poling sets in. Once cutting has commenced on any plant, subsequent cuttings will be taken at stages of every twenty leaves produced. The sub-treatments comprise light, normal and heavy cuttings. Measurements of fibre fineness will be made on the Station.

Fertility Trial

Layout : Six randomized blocks of six plots each having two sub-plots.
Plot size : Twenty-four plants spaced 4m. × 1m. × 1m. (4,000 plants per hectare).

Treatments :

First Cycle		Fallow Period
A — Disc-harrow clean weeding	...	Second cycle of sisal.
B — ,, ,, ,,	...	Two years bush fallow.
C — ,, ,, ,,	...	Two years leguminous fallow.
D — ,, ,, ,,	...	Two years Elephant grass fallow.
E — Cover crop (*Glycine javanica*)	...	Sisal and cover crop.
F — Elephant grass intercropped for first two years.	...	Elephant grass for the first two years.

Sub-treatments :—(i) Six months cutting cycle; (ii) Nine months cutting cycle.

Table XIII.—Fertility Trial 1944

	Fibre Yield tons per Ha	Mean No. leaves Grown per plant	Cut per plant
A	5·35	152·8	95·2
B	4·93	150·7	95·9
C	5·46	151·7	95·6
D	5·31	152·9	96·2
E	4·93	145·0	92·6
F	2·86	125·6	76·5
Significant Difference ...	0·97	7·43	8·32

As might be expected the differences between the treatments are not significant except for the depressing effect of intercropping sisal with elephant grass for the first two years. Most of this sisal is of fairly massive proportions despite early onset of cutting and the next two cuttings should give satisfactory fibre yields. The results of the cover crop treatment runs close to those for the clean weeding treatments.

Comparative Trial of *A. amaniensis* Hybrids—1944

Layout : Six randomized blocks of twelve plots spacing 3 × 1m.

Each plot in this trial contains ten plants which are the vegetative progeny of selected *A. amaniensis* × *A. angustifolia* hybrids made at Amani. Current results of two cuttings are given in Table XIV.

Table XIV

Hybrid No.	Fibre Yield in tons per Ha.	Mean No. leaves Cut per plant	Mean Wt. of a single leaf (gms.) 1st Cut	2nd Cut
A. 335	4·22	117	376	547
A. 364	3·19	111	322	465
A. 15	2·81	92	300	459
A. 26	3·15	172	249	320

Hybrid No.	Fibre Yield in tons per Ha.	Mean No. leaves Cut per plant	Mean Wt. of a single leaf (gms.) 1st Cut	2nd Cut
A. 27	1·57	73	246	362
A. 38	4·77	138	370	436
A. 49	5·77	140	368	450
A. 92	2·80	104	319	434
A. 141	4·54	134	341	349
A. 323	4·25	118	405	505
A. amaniensis	3·40	63	474	706
Significant difference	0·79	38		

It will not be possible to discriminate between these hybrids until they have poled and total yields and resistance to disease are known. A number are high leaf producers though this is generally accompanied by a higher leaf. A.38 and A.49 appear to be the most promising and many are superior to *A. amaniensis* in regard to yield of fibre.

G. W. Lock,
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APPENDIX I

Rainfall Records in Inches

Month	Mean 1935-46	1947
January	1·16	1·17
February	1·62	0·58
March	4·72	3·24
April	7·43	9·66
May	10·45	8·96
June	2·46	1·89
July	1·53	0·02
August	2·43	1·71
September	3·87	3·81
October	4·75	2·60
November	4·31	4·03
December	2·30	4·37
Mean	47·23	Total 42·04

Printed by the Government Printer Dar es Salaam. 60259/3-49/1050—Price Cts. 50 (6d)